

What is claimed is:

1 1. A protection switch in a node of a two-fiber optical channel shared protection ring,
2 the node including a plurality of primary clients and a plurality of pre-emptible clients, each
3 fiber in the two-fiber optical channel shared protection ring propagating at least one working
4 wavelength channel dedicated to primary client traffic and at least one protection wavelength
5 channel which may accommodate extra client traffic, the protection switch comprising:

6 an optical signal monitor coupled to the two-fiber optical channel shared protection
7 ring, the optical signal monitor being operative to detect multi-wavelength channel failures
8 and single wavelength channel failures in the two-fiber optical channel shared protection
9 ring; and

10 an electrical switching circuit coupled to the optical signal monitor, the electrical
11 switching circuit being comprised of a plurality of modular switching fabrics, each modular
12 switching fabric of the plurality of modular switching fabrics including a ring switch mode
13 that is responsive to at least one of the multi-wavelength channel failures, and a span switch
14 mode that is responsive to at least one of the single wavelength channel failures.

1 2. The protection switch of claim 1, wherein the ring switch is operative to switch a
2 primary client's transmission signal from a working wavelength propagating on a first fiber of
3 the two fibers to a protection wavelength propagating on a second fiber of the two fibers,
4 switch the primary client's receive signal from a working wavelength propagating on the
5 second fiber to a protection wavelength propagating on the first fiber, and pre-empt the extra
6 client traffic.

1 3. The protection switch of claim 2, wherein the multi-wavelength channel failure is a
2 cable cut severing the first fiber and the second fiber between a first node and a second node
3 in the ring.

1 4. The protection switch of claim 1, wherein the span switch is operative to switch a
2 primary client's transmission signal from a working wavelength propagating on the first fiber

3 to a protection wavelength propagating on the first fiber, and switch a primary client's receive
4 signal from a working wavelength propagating on the second fiber to a protection wavelength
5 propagating on the second fiber.

1 5. The protection switch of claim 4, wherein the single wavelength channel failure
2 includes an inoperative working wavelength channel.

1 6. The protection switch of claim 1, wherein each modular switching fabric includes
2 a controller programmed to respond to the single wavelength channel failure and the
3 multi-wavelength channel failure.

1 7. The protection switch of claim 1, wherein each modular switching fabric includes
2 a plurality of 2 x 1 switches, and a plurality of 3 x 1 switches.

1 8. The protection switch of claim 7, wherein the plurality of 2 x 1 switches and the
2 plurality of 3 x 1 switches are fabricated using gated semiconductor devices.

1 9. The protection switch of claim 7, wherein the plurality of 2 x 1 switches and the
2 plurality of 3 x 1 switches are fabricated using data selectors.

1 10. The protection switch of claim 1, further comprising:
2 a first add multiplexer coupled to the first fiber and the electrical switching circuit;
3 a first drop multiplexer coupled to the first fiber and the electrical switching circuit;
4 a second add multiplexer coupled to the second fiber and the electrical switching
5 circuit; and
6 a second drop multiplexer coupled to the second fiber and the electrical switching
7 circuit.

1 11. The protection switch of claim 10, wherein the first add multiplexer, the first drop
2 multiplexer, the second add multiplexer, and the second drop multiplexer operate in a range
3 of wavelengths including 1550nm.

1 12. The protection switch of claim 10, wherein the first add multiplexer inserts the
2 primary client's transmission onto the first fiber using a first fiber working wavelength
3 channel.

1 13. The protection switch of claim 10, wherein the first add multiplexer inserts the
2 primary client's transmission onto the first fiber using a first fiber protection wavelength
3 channel in response to a multi-wavelength channel failure.

1 14. The protection switch of claim 10, wherein the second add multiplexer inserts the
2 primary client's transmission onto the second fiber using a second fiber working wavelength
3 channel.

1 15. The protection switch of claim 10, wherein the second add multiplexer inserts the
2 primary client's transmission onto the second fiber using a second fiber protection wavelength
3 channel in response to a single wavelength channel failure.

1 16. The protection switch of claim 10, wherein the first drop multiplexer drops a first
2 fiber working wavelength channel from the first fiber to thereby route the primary client's
3 receive signal to the electrical switching circuit.

1 17. The protection switch of claim 10, wherein the first drop multiplexer drops a first
2 fiber protection wavelength channel from the first fiber to thereby route the primary client's
3 receive signal to the electrical switching circuit in response to a multi-wavelength channel
4 failure.

1 18. The protection switch of claim 10, wherein the second drop multiplexer drops a
2 second fiber working wavelength channel from the second fiber to thereby route the primary
3 client's receive signal to the electrical switching circuit.

1 19. The protection switch of claim 10, wherein the second drop multiplexer drops a
2 second fiber protection wavelength channel from the second fiber to thereby route the

3 primary client's receive signal to the electrical switching circuit in response to a single
4 wavelength channel failure.

1 20. The protection switch of claim 10, further comprising:

2 a first optoelectric converter coupled to the first drop multiplexer and a modular
3 switching fabric, the first optoelectric converter adapted to convert a first fiber working
4 wavelength channel dropped from the first fiber into a first data signal readable by the
5 modular switching fabric;

6 a second optoelectric converter coupled to the first drop multiplexer and the modular
7 switching fabric, the second optoelectric converter adapted to convert a first fiber protection
8 wavelength channel dropped from the first fiber into a second data signal readable by the
9 modular switching fabric;

10 a third optoelectric converter coupled to the second drop multiplexer and the modular
11 switching fabric, the third optoelectric converter adapted to convert a second fiber working
12 wavelength channel dropped from the second fiber into a third data signal readable by the
13 modular switching fabric; and

14 a fourth optoelectric converter coupled to the second drop multiplexer and the
15 modular switching fabric, the fourth optoelectric converter adapted to convert a second fiber
16 protection wavelength channel dropped from the second fiber into a fourth data signal
17 readable by the modular switching fabric.

1 21. The protection switch of claim 20, wherein the modular switching fabric further
2 comprises:

3 a first 3 x 1 switch having inputs coupled to the first optoelectric converter, second
4 optoelectric converter, third optoelectric converter, and an output coupled to a first primary
5 client receiver;

6 a first 2 x 1 switch having inputs coupled to the second optoelectric converter and an
7 output coupled to a first extra client receiver;

8 a second 3 x 1 switch having inputs coupled to the second optoelectric converter, third
9 optoelectric converter, fourth optoelectric converter, and an output coupled to a second
10 primary client receiver;

11 a second 2 x 1 switch having inputs coupled to the third optoelectric converter and an
12 output coupled to a second extra client receiver; and
13 a controller coupled to the first 2 x 1 switch, the second 3 x 1 switch, the second 2 x 1 switch,
14 and the second 2 x 1 switch, the controller being operative to actuate the switches in response
15 to the multi-wavelength channel failure, whereby the primary client's receive signal is
16 received from a protection wavelength channel propagating on the first fiber instead of from a
17 working wavelength channel propagating on the second fiber, and the extra client traffic is
18 pre-empted.

1 22. The protection switch of claim 21, wherein the controller is operative to actuate
2 the switches to receive the primary client's receive signal from a protection wavelength
3 propagating on a fiber instead of a working wavelength channel on the fiber in response to
4 the at least one fault condition being an inoperative working wavelength channel.

1 23. The protection switch of claim 10, further comprising:

2 a first electrooptic converter coupled to the first add multiplexer and a modular
3 switching fabric, the first electrooptic converter adapted to convert a first data signal received
4 from the modular switching fabric into a first-fiber wavelength channel to be added to first
5 fiber traffic;

6 a second electrooptic converter coupled to the first drop multiplexer and the modular
7 switching fabric, the second electrooptic converter adapted to convert a second data signal
8 received from the modular switching fabric a second first-fiber wavelength channel to be
9 added to first fiber traffic;

10 a third electrooptic converter coupled to the second drop multiplexer and the modular
11 switching fabric, the third electrooptic converter adapted to convert a third data signal
12 received from the modular switching fabric into a second-fiber wavelength channel to be
13 added to second fiber traffic; and

14 a fourth electrooptic converter coupled to the second drop multiplexer and the
15 modular switching fabric, the fourth electrooptic converter adapted to convert a fourth data
16 signal received from the modular switching fabric into a second second-fiber wavelength
17 channel to be added to second fiber traffic.

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1 24. The protection switch of claim 23, wherein the modular switching fabric further,
2 comprises:

3 a first 3 x 1 switch having an output coupled to the second electrooptic converter, and
4 inputs coupled to a first primary client transmitter, a first extra client transmitter, and a
5 second primary client transmitter;

6 a first 2 x 1 switch having an input coupled to the first extra client transmitter and an
7 output connected to the first 3 x 1 switch;

8 a second 3 x 1 switch having an output coupled to the third electrooptic converter, and
9 inputs coupled to a first primary client transmitter, a second extra client transmitter, and a
10 second primary client transmitter;

11 a second 2 x 1 switch having an input coupled to the second extra client transmitter
12 and an output connected to the second 3 x 1 switch; and

13 a controller coupled to the first 3 x 1 switch, the second 3 x 1 switch, the first 2 x 1
14 switch, and the second 2 x 1 switch, the controller being operative to actuate the switches in
15 order to switch a primary client's transmission signal from a working wavelength channel
16 propagating on a first fiber to a protection wavelength channel propagating on a second fiber
17 in response to the multi-wavelength channel failure.

1 25. The protection switch of claim 24, wherein the controller is operative to switch a
2 primary client's transmission signal from the working wavelength channel propagating on the
3 first fiber to the protection wavelength channel propagating on the first fiber in response to a
4 single wavelength channel failure.

1 26. The protection switch of claim 1, further comprising:

2 a plurality of electrooptic converters coupled to a modular switching fabric and a
3 plurality of client receivers, the plurality of electrooptic converters being operative to convert
4 working data signals and extra data signals transmitted by the electrical switch circuit into
5 1310nm optical signals for reception by the plurality of client receivers; and

6 a plurality of optoelectric converters coupled to the modular switching fabric and a
7 plurality of client transmitters, the plurality of optoelectric converters being operative to convert

8 1310nm optical signals transmitted from the plurality of client transmitters into working data
9 signals and protection data signals for use by the modular switching fabric.

1 27. The protection switch of claim 1, wherein each modular switching fabric includes
2 an application specific integrated circuit (ASIC).

1 28. A modular switching fabric for use in a protection switch resident in a node of a
2 two-fiber optical channel shared protection ring, each node including a plurality of primary
3 clients and a plurality of pre-emptible clients, each fiber of the two fibers propagating at least
4 one working wavelength channel dedicated to primary client traffic and at least one
5 protection wavelength channel which may accommodate extra client traffic, the protection
6 switch comprising:

7 a first 3 x 1 switch coupled to a first primary client receiver;

8 a first 2 x 1 switch coupled to a first extra client receiver;

9 a second 3 x 1 switch coupled to a second primary client receiver;

10 a second 2 x 1 switch coupled to a second extra client receiver; and

11 a controller coupled to the first 3 x 1 switch, the second 3 x 1 switch, the first 2 x 1
12 switch, and the second 2 x 1 switch, the controller being operative to actuate the switches in
13 order to receive the primary client's receive signal from a protection wavelength propagating
14 on the first fiber instead of a working wavelength channel propagating on the second fiber,
15 and pre-empt extra client traffic, in response to a multi-wavelength channel failure.

1 29. The two-fiber optical channel shared protection ring of claim 26, wherein the
2 controller is operative to actuate the switches to receive the primary client's receive signal
3 from a protection wavelength propagating on a fiber instead of a working wavelength channel
4 on the fiber in response to a single wavelength channel failure.

1 30. A two-fiber optical channel shared protection ring for bi-directional
2 communications between a plurality of nodes, each node including a plurality of primary
3 clients and a plurality of pre-emptible clients, each fiber of the two fibers propagating at least
4 one working wavelength channel dedicated to primary client traffic and at least one

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5 protection wavelength channel which may accommodate extra client traffic, the protection
6 switch comprising:

7 a first 3 x 1 switch having inputs coupled to a first primary client transmitter, a first
8 extra client transmitter, and a second primary client transmitter;

9 a first 2 x 1 switch having an input coupled to the first extra client transmitter and an
10 output connected to the first 3 x 1 switch;

11 a second 3 x 1 switch having inputs coupled to a first primary client transmitter, a
12 second extra client transmitter, and a second primary client transmitter;

13 a second 2 x 1 switch having an input coupled to the second extra client transmitter
14 and an output connected to the second 3 x 1 switch; and

15 a controller coupled to the first 3 x 1 switch, the second 3 x 1 switch, the first 2 x 1
16 switch, and the second 2 x 1 switch, the controller being operative to actuate the switches in
17 order to switch a primary client's transmission signal from a working wavelength propagating
18 on a first fiber of the two fibers to a protection wavelength propagating on a second fiber of
19 the two fibers in response to a multi-wavelength channel failure.

1 31. The protection switch of claim 30, wherein the controller is operative to switch a
2 primary client's transmission signal from the working wavelength propagating on the first
3 fiber to the protection wavelength propagating on the first fiber in response to a single
4 wavelength channel failure.

1 32. A method for switching bi-directional traffic between a plurality of nodes in a
2 two-fiber optical channel shared protection ring, each node including a plurality of primary
3 clients and a plurality of pre-emptible clients, each fiber of the two fibers propagating at least
4 one working wavelength channel dedicated to primary client traffic and at least one
5 protection wavelength channel which may accommodate extra client traffic, the method
6 comprising:
7 providing a protection switch in each node of the plurality of nodes, each protection
8 switch being coupled to the two fibers, the plurality of primary clients, and the plurality of
9 pre-emptible clients, wherein the protection switch includes a plurality of modular switching
10 fabrics;

11 detecting a fault condition in the two-fiber optical channel shared protection ring;
12 actuating at least one of the modular switching fabrics in response to the step of
13 detecting, whereby a primary client's transmission signal is switched from a working
14 wavelength propagating on a first fiber of the two fibers to a protection wavelength
15 propagating on a second fiber of the two fibers, switching the primary client's receive signal
16 from a working wavelength propagating on the second fiber to a protection wavelength
17 propagating on the first fiber, and pre-empting extra client traffic.

1 33. The method of claim 32, wherein the fault condition is a
2 multi-wavelengthchannel failure.

1 34. The method of claim 32, wherein the step of actuating includes switching a
2 primary client's transmission signal from the working wavelength propagating on the first
3 fiber to the protection wavelength propagating on the first fiber, and switching the primary
4 client's receive signal from a working wavelength propagating on the second fiber to a
5 protection wavelength propagating on the second fiber.

1 35. The method of claim 34, wherein the fault is a single wavelength channel failure.